From these facts and from closely similar observations on aviators[2] during the war, it appears highly probable that in normal persons the blood alkali is controlled by the dissolved CO_2: more or less alkali being called into use in the blood to satisfy the equation above quoted, and to keep the C_H of the blood constant. The amount of dissolved CO_2 in the blood is controlled by the pulmonary ventilation; and fundamentally the ventilation is adjusted to the oxygen partial pressure of the air at the altitude at which the person lives.

Thus, as data from the report of the Pike's Peak expedition[3] tend to confirm, the partial pressure of oxygen in the lungs, the alveolar CO_2, the $CO_2(H_2CO_3)$ dissolved in the blood, and the amount of the blood alkali (the so-called "alkaline reserve"), each multiplied by a constant of its own, tend to vary in direct proportion to the mean barometer, minus the water vapor tension of the pulmonary air (about 45 mm.) at all altitudes.

[1] Haggard, H. W., and Henderson, Yandell, *J. Biol. Chem.*, **39**, No. 1, August, 1919 (163–261).

[2] Henderson, Yandell, *Science, New York*, N. S., **49**, No. 1271, May 9, 1919 (431–441).

[3] Douglas, Haldane, Henderson, and Schneider, *London Phil. Trans. Roy. Soc.*, B. **203**, 1913 (310).

A STUDY OF ABSORPTION SPECTRA WITH THE ELECTRIC FURNACE

By ARTHUR S. KING

MOUNT WILSON OBSERVATORY, CARNEGIE INSTITUTION OF WASHINGTON

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The tube resistance furnace has found a place as a useful light-source in spectroscopic work, but thus far it has been used mainly for the production of emission spectra. The long column of vapor, whose temperature can be controlled, offers interesting possibilities, however, in the field of absorption phenomena. In the experiments to be described, the continuous background was supplied by a plug of graphite placed in the center of the furnace tube, the heated portion of which was 20 cm. long and 12.5 mm. internal diameter. A close approach to black-body conditions is thus obtained, and the emission of the plugged tube is stronger than that of the metallic vapor filling the tube. An absorption spectrum results, which, by simply removing the plug, may be compared with the emission spectrum given by the vapor at the same temperature.

It is known from observations of reversed emission lines that in a given range of spectrum, some lines are more subject to reversal than others. The present experiments have shown this to result from a close connection between the tendency of a line to reverse and the two factors which enter into the classification of lines in furnace spectra, viz., the temperature at which a line is first radiated and its response to increase of temperature.

The phenomena may be briefly described by saying that when a temperature is reached sufficiently high to produce an absorption spectrum, the lines appearing are those of low-temperature class. As the temperature is raised, lines of successively higher classes appear. The lines of low-temperature class thus show the largest degree of absorbing power. At a given temperature, the absorption spectrum shows fewer lines than are given by the emission spectrum at the same temperature. The absent lines are of the higher temperature classes, which the vapor is able to emit, but which have relatively low absorbing power. For the iron and titanium spectra, the absorption spectrum is very similar to that given in emission at a temperature about 400° lower. As lines which are strong in the furnace and faint in the arc are usually lines of large absorptive power, the difference between the arc and the dark-line furnace spectrum is very striking.

The dependence of absorptive power on temperature class was well brought out by placing the graphite plug beyond the center of the tube away from the spectrograph, so that some of the metallic vapor was hotter than the plug. It was then possible to obtain emission and absorption lines at the same time. The high-temperature lines appeared in emission, while the plug was still hot enough to cause those of low-temperature class to show as absorption lines.

Lines which are being emitted by a vapor may fail to appear in absorption owing either to a low absorptive power and consequent quenching by the continuous spectrum, or to a balancing of emission and absorption which may occur when the continuous background is reduced in temperature so that its emission is of about the same strength as that from the metallic vapor. This latter condition was produced in the furnace by withdrawing the plug nearly to the end of the tube. Lines produced by the vapor in the central portion were then frequently neutralized by the balanced emission and absorption and were not to be seen. In this way a line may seem to be totally absent when in reality it is being strongly radiated by the vapor.

A method of producing absorption spectra without the use of a plug may be mentioned in this connection. When the furnace is operated in the usual way, with a metallic powder or salt in the open tube, the emission spectrum increases in intensity and number of lines as the temperature is raised, until it compares in richness with that of the arc. A still higher temperature causes a rapid increase in a continuous ground, which is probably due in part to the long column of dense metallic and carbon vapor and partly to light from the walls of the tube reflected by the vapor particles. This obliterates the emission lines and we have an absorption spectrum consisting of the lines which in the high-temperature emission spectrum were self-reversed. In general these are low-temperature lines, although they result from a high-temperature condition. This phenomenon may

occur with the furnace in vacuo, so that the continuous spectrum cannot be regarded as resulting from a high-pressure condition. The possibility of producing an absorption spectrum accompanied by the suppression of many lines which are being emitted strongly at this temperature must be considered when dealing with an extended mass of vapor.

A STUDY OF THE EFFECT OF A MAGNETIC FIELD ON ELECTRIC FURNACE SPECTRA

BY ARTHUR S. KING

MOUNT WILSON OBSERVATORY, CARNEGIE INSTITUTION OF WASHINGTON

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Investigations on the splitting of spectrum lines by the magnetic field have employed, except in rare instances, the electric spark as the source of light. It has proved impracticable to maintain an arc between the poles of a magnet, though an apparatus giving a succession of flashes has been employed. The flame, because of its weak luminosity, has but limited usefulness. The electric furnace, if its size does not prevent its use in the magnetic field, will evidently do work not at present taken care of. While the furnace does not give the enhanced lines peculiar to the spark, the other lines shown by the arc and spark occur for the most part in the furnace spectrum. In addition, the furnace is found to show a large number of lines which are produced only with great difficulty by either the arc or the spark, and for which we have as yet no data as to their magnetic separation. A further advantage over the spark for the lines common to both is the extreme sharpness of furnace lines when the apparatus is enclosed in a vacuum chamber, a feature which should add materially to the definition of the Zeeman components.

Pending the construction of a more powerful apparatus, a simple tube furnace was arranged for use in a magnetic field. A graphite tube, 10 cm. long, was placed axially between the poles of a Weiss electro-magnet. The jacket enclosing the tube and the contact blocks at the ends were water-cooled. A field of 6500 gausses separated the n components of most lines sufficiently to permit measurements of fair accuracy and to show the characteristic features of the source. The spectra of iron and vanadium received the chief attention, and measurements were made for a considerable number of lines having well-defined components. A comparison of lines common to furnace and spark showed no difference either in the number and arrangement of components, or in their separation in the two sources, the very different excitation in the two cases appearing to have no effect on the magnetic characteristics. The furnace and spark can thus be used to supplement each other in studying the magnetic behavior of all classes of lines. As was expected, separations were obtained for